

2004 SPAWNING LAKE TROUT ASSESSMENT

INTRODUCTION

Recovery of the historical spawning shoals has been an essential component of lake trout rehabilitation in the Wisconsin waters of Lake Superior. Creation of refuges/special use areas adjacent to spawning shoals and more restrictive regulations and the astro-turf program was intended to increase lake trout abundance. Although wild lake trout abundance has increased dramatically since the 1960s and stocking was concluded in 1995 for WI-2, maintaining or continuing to increase spawner biomass is essential to a self-sustaining population. The objective of this assessment is to quantify lake trout abundance on historically important spawning shoals and to collect lake trout eggs for the Bayfield hatchery for the lake trout and splake stocking programs.

METHODS

The standard index gang set on Gull Island Shoal (GIS) was 2,700 ft of 5.5-in and 6-in (stretch measure) monofilament mesh (6, 5.5, 6, 5.5, 6, 5.5, 6, 5.5, 6). Each net within the gang was 300 feet long. The standard index gang on Michigan Island Shoal (MIS) was divided: 1,500 ft (6, 5.5, 6, 5.5, 6) set off Michigan Island, and 1,200 ft (6, 5.5, 6, 5.5) set off Gull Island.

The standard index gang set on Sand Cut Reef (SCR) was 3,900 ft of graded monofilament mesh. Each net was 300 ft long and was arranged in the following sequence: 6, 5.5, 7, 4.5, 6.5, 5, 6, 5, 6.5, 4.5, 7, 5.5, 6. On SCR the gang was divided between the two humps: 1,800 ft on the west hump and 2,100 ft on the east hump.

An index gang (3,900 ft of graded monofilament mesh) was set on Devils Island Shoal (DIS). Each net was 300 ft long and was arranged in the following sequence: 6, 5.5, 7, 4.5, 6.5, 5, 6, 5, 6.5, 4.5, 7, 5.5, 6.

All live fish were measured to the nearest tenth of an inch, sexed, tagged, inspected for sea lamprey marks, and released. Otoliths and scales were removed from the dead, native fish.

Fish age was estimated by examining sectioned sagittal otolith planes.

The recapture of previously tagged lake trout has allowed for annual estimation of the spawning population on Gull-Michigan Island Complex. Abundance of male lake trout was estimated using the Lincoln-Peterson population model with Bailey's modification. The number of females was then estimated using the sex ratio from the assessment catch.

Results/Discussion

GULL ISLAND SHOAL

In 2004, 1,019 spawning lake trout were sampled on GIS and 95% were native fish. Female lake trout constituted 10% of the sample. Lake trout catch-per-unit-effort (CPUE) decreased from 2003 to 2004 (Table 1). Spawning lake trout CPUE has increased dramatically since 1960, when no females were caught during the spawning assessments (Figure 1). Mean lengths of male and female lake trout were 28.5 in (SD=2.8) and 31.3 in (SD=3.3), respectively.

MICHIGAN ISLAND SHOAL

In 2004, 394 lake trout were sampled on MIS. Native fish constituted 97% of the catch and females comprised 8% of the catch. Lake trout CPUE decreased from 2003 to 2004 (Table 1). Mean lengths of male and female lake trout were 28.2 in (SD=2.8) and 31.3 in (SD=2.5), respectively.

GULL - MICHIGAN ISLAND COMPLEX

The GIS-MIS data for wild and hatchery-origin females were combined to monitor trends. Lake trout CPUE for all size intervals decreased from 2003 to 2004 (Table 2). Although variable between 1985 and 1995, the abundance of native females has increased gradually since 1964 (Figure 2). The annual proportion of females in the catch, also highly variable, has not consistently increased since the 1970s (Figure 3). The annual proportion of hatchery lake trout in the catch continues to decrease, however hatchery fish were a large component of the catch during assessments in the 1960s and 1970s (Figure 4).

Following is a breakdown of the 2004 GIS-MIS spawning population:

Native Males	14,511 ± 4692
Native Females	1,481
Hatchery-origin Males	610
Hatchery-origin Females	<u>136</u>
	16,738

Due to mesh size selectivity, smaller males recruiting into the spawning stock were not sampled. Thus the estimate of spawning lake trout abundance and egg deposition may be underestimated. Spawning lake trout abundance decreased from 2003 to 2004 (Table 3). Egg deposition was estimated at 10.9 million eggs.

Lake trout from 2002 through 2004 were combined to evaluate age composition of spawners at GIS complex. Twenty-eight lake trout year classes were represented in the sample of GIS complex in 2004 (Table 4).

Less than 25% of sea lamprey wounds on lake trout from GIS complex were fresh (A1-A3) (Table 5).

SAND CUT REEF

In 2004, 163 lake trout were sampled on SCR. Native fish comprised 93% of the catch and female lake trout comprised 12.3% of the catch. Catch-per-effort of spawning lake trout increased from 2003 to 2004 (Table 6).

Lake trout captured from SCR had few sea lamprey wounds (Table 5). Close proximity to productive sea lamprey spawning river (Bad River) and low wounding rates indicate either the sea lamprey do not feed near the river or the lake trout that spawn on SCR do not spend substantial time near the river when not spawning.

DEVILS ISLAND SHOAL

In 2004, 265 lake trout were captured on DIS of which 98% were unclipped, native fish. Catch-per-unit-effort in 2004 was lower than in 2001 but dramatically higher than in the 1970s (Table 7). Sampling in 2004 was only the second visit to DIS by WIDNR since the astro-turf program concluded in 1994.

Age composition of spawning lake trout from DIS shifted from 2001 to 2004 (Figure 6). In 2004, fish from year classes since 1994 were captured and may represent offspring of lake trout from the early astro-turf stocking.

Similar to SCR, sea lamprey wounding rates were much lower than at GIS complex (Table 5).

2004 EGG HARVEST

Approximately 186,610 lake trout eggs and 71,300 splake eggs were collected by the Bayfield Fish Hatchery for the lake trout and splake stocking programs.

Figure 1. Catch-per-unit-effort of lake trout from spawning assessment at Gull Island Shoal, 1951-2004.

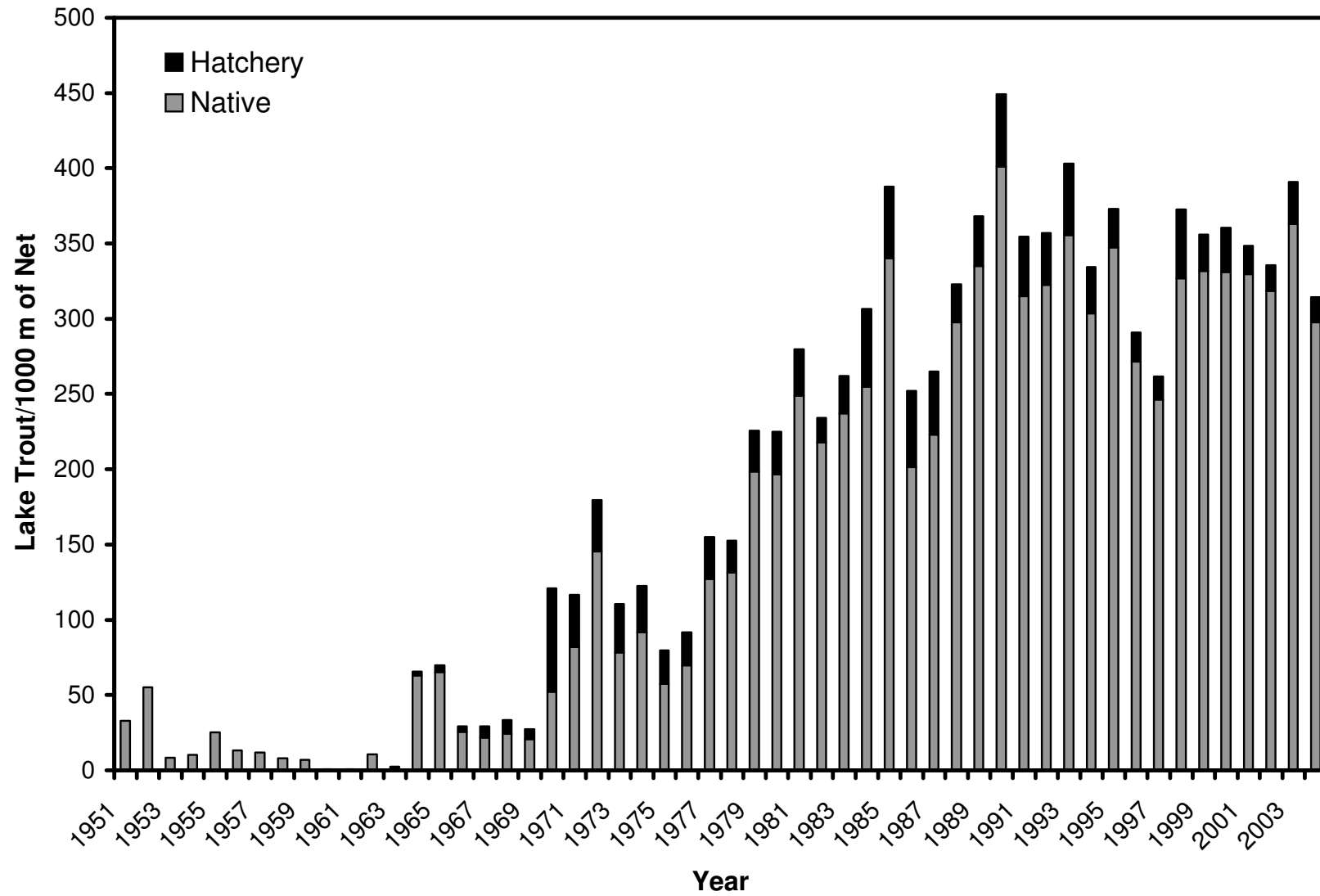


Figure 2. Female lake trout catch-per-unit-effort from spawning assessment at Gull-Michigan Island Complex, 1964-2004.

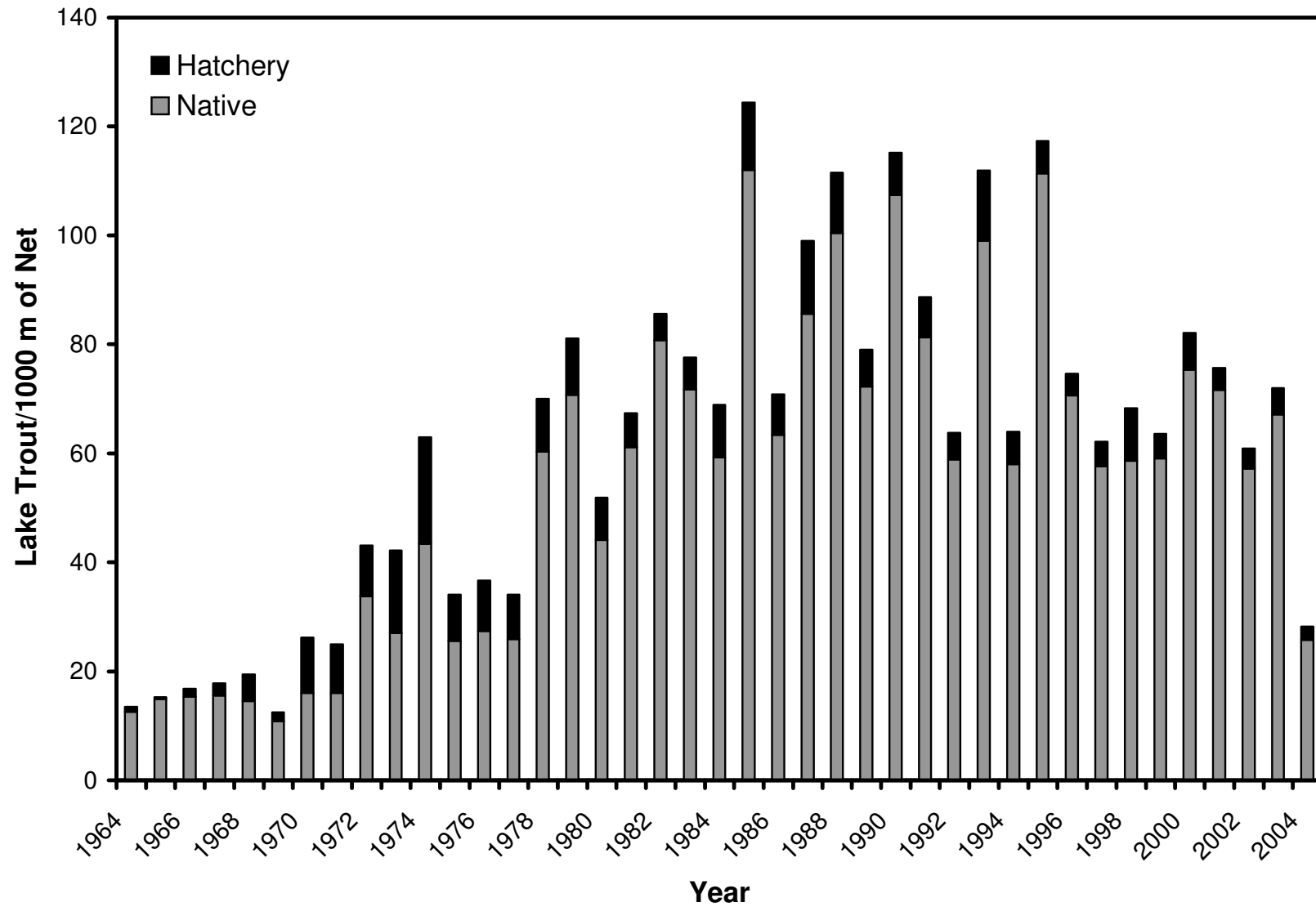


Figure 3. Mean annual proportion of female lake trout in the catch from the Gull-Michigan Island Complex during the spawning assessment, 1964-2004.

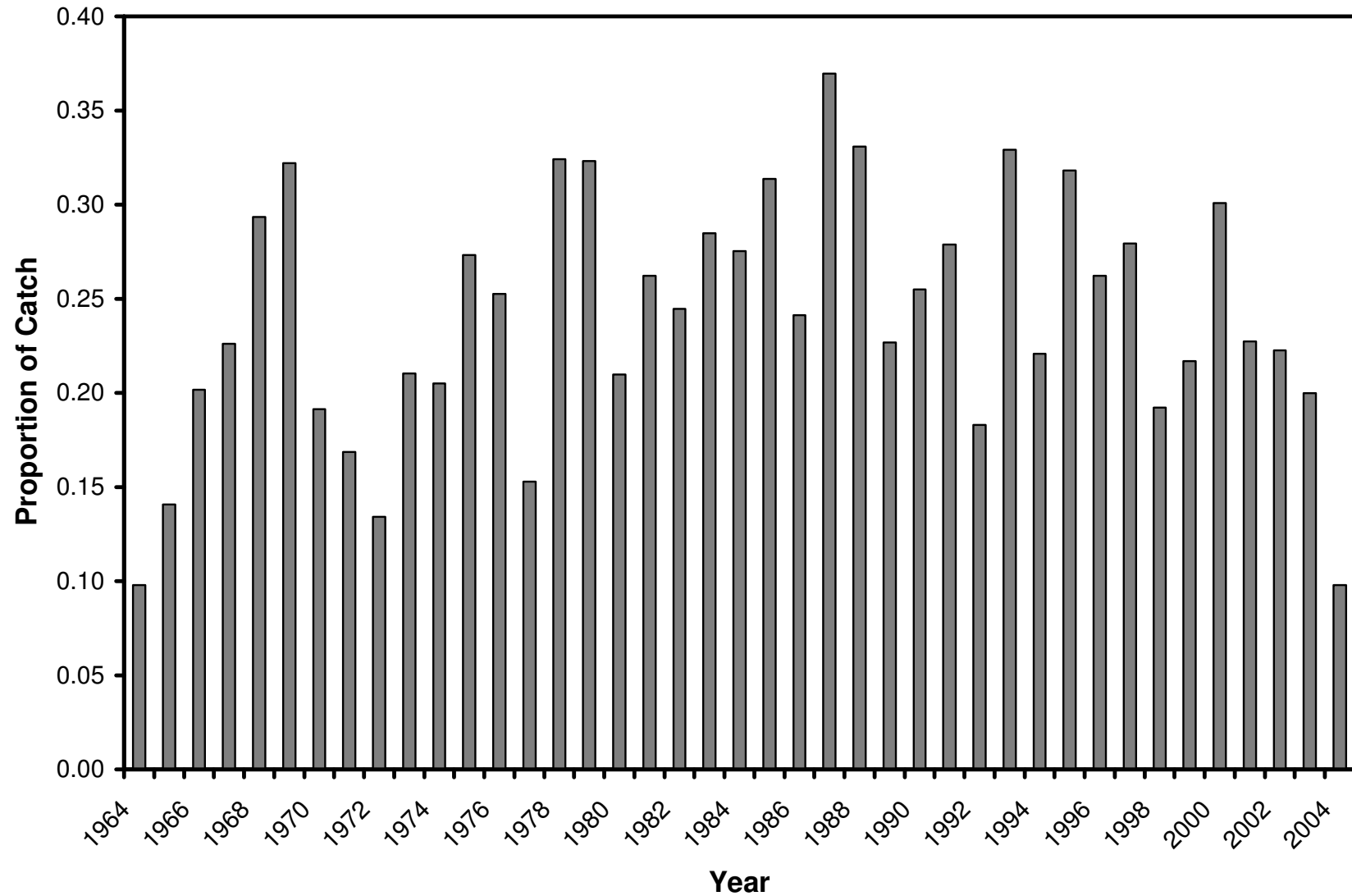


Figure 4. Mean annual proportion of hatchery lake trout in the catch from Gull-Michigan Island Complex during the spawning assessment, 1964-2004.

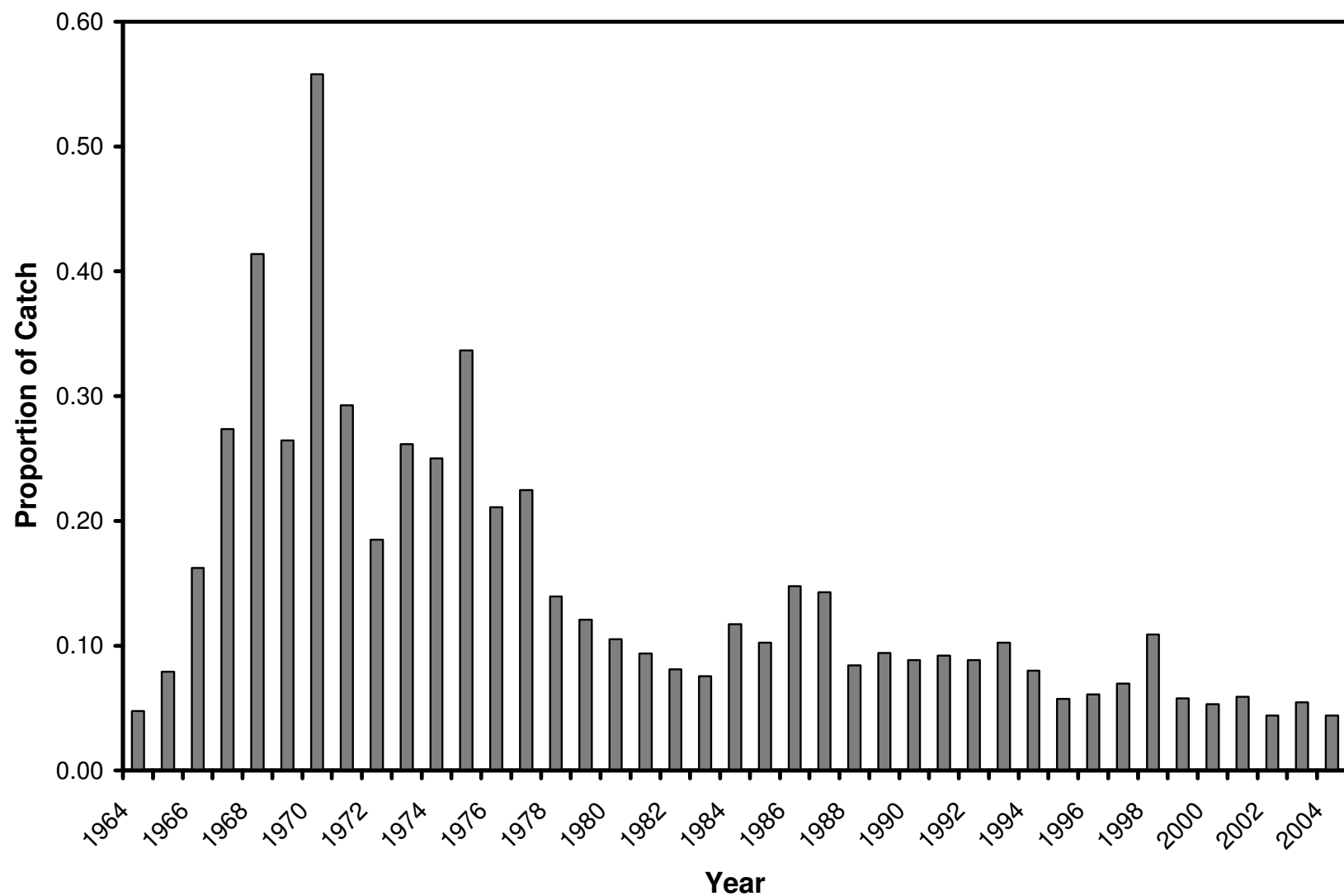


Figure 5. Age composition of lake trout sampled during spawning assessment at Devils Island Shoal, 2001 and 2004.

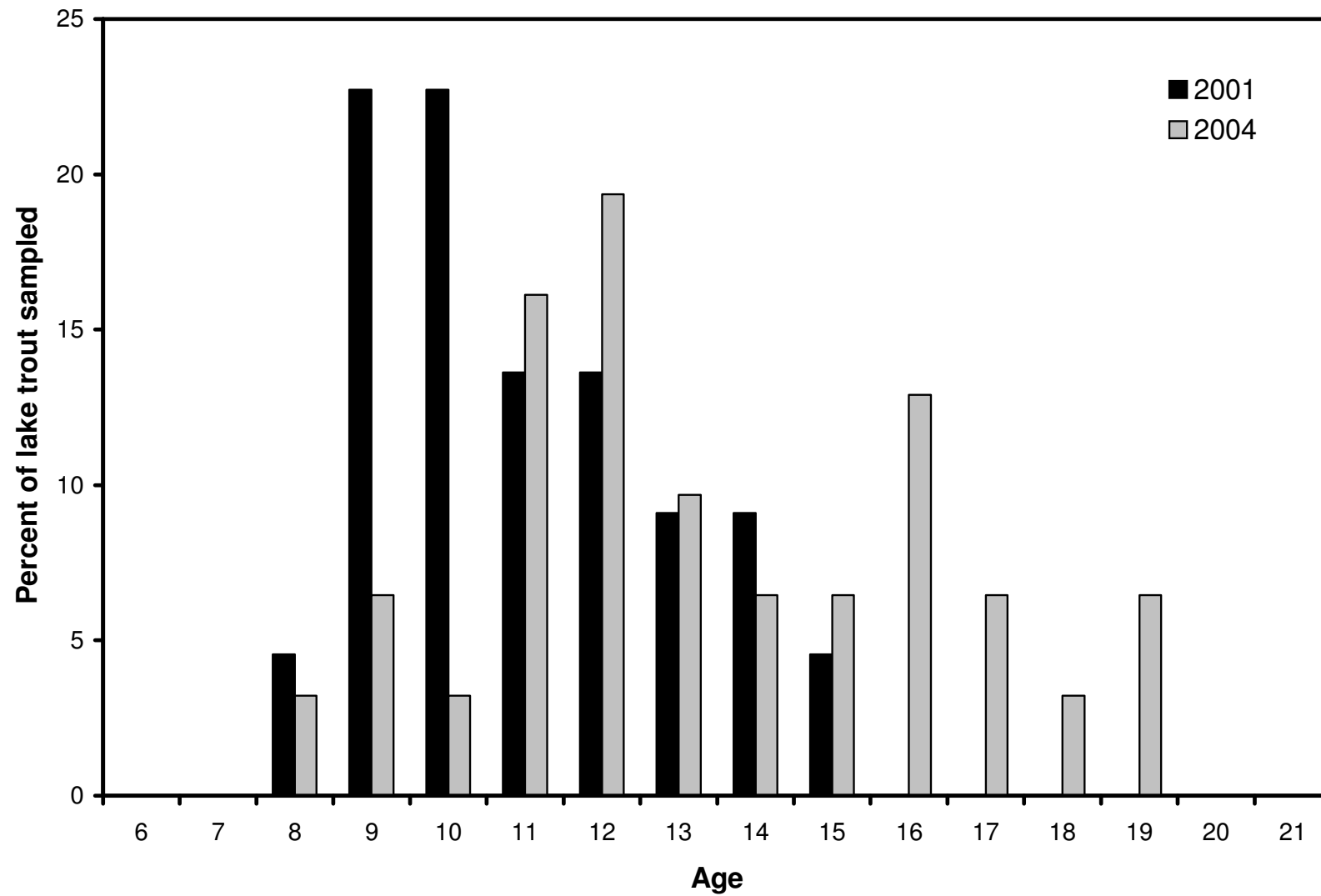


Table 1. Lake trout catch per 1,000 feet of net (CPUE) and effort (ft) fished for 5.5-in and 6-in mesh nets on Gull Island and Michigan Island Shoals, 1982-2004.

Year	Gull Island Shoal				Michigan Island Shoal			
	5.5" CPUE	Ft. of Net	6" CPUE	Ft. of Net	5.5" CPUE	Ft. of Net	6" CPUE	Ft. of Net
1982	136.7	3,000	68.9	5,400	143.3	1,200	87.9	2,400
1983	101.4	5,700	62.9	7,500	140.0	1,500	58.1	2,100
1984	125.0	4,500	74.4	8,100	135.5	2,700	75.9	6,300
1985	149.6	2,400	82.0	3,000	253.3	1,800	73.9	3,600
1986	97.7	4,800	73.2	6,000	174.2	2,400	103.0	3,000
1987	95.6	4,800	66.7	6,000	117.1	2,400	68.3	3,000
1988	115.4	4,800	82.5	6,000	137.5	2,400	94.3	3,000
1989	148.5	4,800	80.3	6,000	132.1	2,400	84.7	3,000
1990	173.3	2,400	104.0	3,000	187.5	2,400	105.7	3,000
1991	111.5	4,800	102.0	6,000	103.8	2,400	68.0	3,000
1992	119.8	4,800	96.8	6,000	98.3	2,400	89.3	3,000
1993	153.3	4,800	121.2	6,000	92.1	2,400	74.7	3,000
1994	116.9	4,800	87.0	6,000	95.0	2,400	58.7	3,000
1995	136.7	3,600	92.0	4,500	151.3	2,400	108.3	3,000
1996	101.3	4,800	77.0	6,000	94.2	1,200	73.3	1,500
1997	87.1	4,800	71.7	6,000	55.8	2,400	55.3	3,000
1998	122.7	4,800	99.8	6,000	110.4	2,400	82.0	3,000
1999	111.3	4,800	103.2	6,000	85.8	2,400	72.3	3,000
2000	117.7	4,800	100.8	6,000	76.3	2,400	58.3	3,000
2001	118.1	4,800	93.8	6,000	105.0	2,400	69.3	3,000
2002	113.1	4,800	91.2	6,000	72.9	2,400	60.3	3,000
2003	135.8	4,800	100.0	6,000	112.9	2,400	95.0	3,000
2004	102.1	4,800	98.7	6,000	84.2	2,400	64.0	3,000

Table 2. Effort (ft) fished, lake trout catch, and lake trout catch per 1,000 feet of net (CPUE) from 5.5-in and 6-in mesh nets on the Gull-Michigan Island Complex, 1982-2004.

Year	Effort (Feet)	21 – 24.9"		25 – 28.9"		29" ≤	
		No.	CPUE	No.	CPUE	No.	CPUE
1982	12,000	63	5.3	721	60.1	380	31.7
1983	18,600	171	9.2	838	45.1	519	27.9
1984	18,000	242	13.4	898	49.9	417	23.2
1985	10,800	191	17.7	862	79.8	286	26.5
1986	16,200	199	12.3	1,035	63.9	308	19.0
1987	16,200	171	10.6	823	50.8	351	21.7
1988	16,200	228	14.1	1,139	70.3	294	18.1
1989	16,200	292	18.0	1,259	77.7	213	13.1
1990	10,800	201	18.6	1,047	96.9	247	22.9
1991	16,200	155	9.6	945	58.3	505	31.2
1992	16,200	206	12.7	948	58.5	506	31.2
1993	16,200	111	6.9	1090	67.3	707	43.6
1994	16,200	73	4.5	946	58.4	464	28.6
1995	13,500	118	8.7	1,034	76.6	441	32.7
1996	13,500	73	5.4	646	47.9	452	33.5
1997	16,200	88	5.4	542	33.4	518	31.9
1998	16,200	104	6.4	786	48.5	808	49.9
1999	16,200	219	13.5	724	44.7	632	39.0
2000	16,200	158	9.8	687	42.4	683	42.2
2001	16,200	182	11.2	790	48.8	619	38.2
2002	16,200	144	8.9	677	41.8	623	38.5
2003	16,200	175	10.8	916	56.5	716	44.2
2004	16,200	102	6.3	736	45.4	575	35.5

Table 3. Estimates of the spawning lake trout abundance and egg deposition in the Gull-Michigan Island Shoal Complex, 1965-2004.

Year	Native Males	Native Females	Hatchery Males	Hatchery Females	Total	Egg Deposition		
						Native	Hatchery	Total
1965	4,599	569		95	5,263			3,100,519
1970	1,302	355	1,754	407	3,818			2,420,024
1975	3,359	1,461	927	392	6,139	8,675,099	2,310,672	10,985,771
1980	12,103	2,689	1,174	528	16,494	16,290,873	3,180,021	19,470,894
1985	1,008	4,549	1,348	520	16,425	24,542,420	2,745,984	27,288,404
1986	10,892	3,513	2,118	460	16,983	18,101,064	2,657,644	20,758,708
1987	9,339	4,915	1,455	783	16,492	26,814,587	4,282,949	31,097,536
1988	9,800	4,261	818	451	15,330	21,427,460	2,274,264	23,701,724
1989	17,104	5,031	1,800	536	24,471	23,824,630	2,722,693	26,547,323
1990	11,877	4,399	1,188	338	17,802	22,491,955	1,764,604	24,256,559
1991	11,931	4,419	1,277	470	18,097	24,912,063	3,029,522	27,941,585
1992	13,184	3,216	1,271	268	17,939	18,809,289	1,648,746	20,458,035
1993	11,194	4,146	1,065	513	16,918	25,129,051	3,141,933	28,270,984
1994	14,564	4,551	1,099	382	20,596	25,853,462	2,346,080	28,199,542
1995	24,875	10,815	1,716	572	37,978	60,375,972	3,359,904	63,735,876
1996	11,362	4,058	834	254	16,508	24,067,246	1,615,708	25,682,954
1997	18,448	6,589	1,239	513	26,789	41,235,473	3,157,772	44,393,245
1998	11,937	2,776	1,486	461	16,660	18,098,010	3,305,949	21,403,959
1999	17,116	4,075	1,028	313	22,532	27,067,069	2,305,715	29,372,784
2000	17,060	5,882	1,147	532	24,621	38,420,244	3,795,136	42,215,380
2001	16,933	5,131	968	294	23,326	32,043,002	1,882,776	33,925,778
2002	15,502	3,164	564	204	16,270	20,500,671	1,266,120	21,766,791
2003	15,673	3,732	1032	275	20,712	25,542,254	2,199,461	27,741,715
2004	14,511	1,481	610	136	16,738	9,846,676	1,049,824	10,896,500

Table 4. Mean length-at-age of lake trout sampled from the Gull Island Shoal Complex, 2002 through 2004.

	Age	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Males	Sample	8	8	15	13	12	19	18	13	29	17	13	18	12	12	15	6	5
	Mean Length (in)	23.8	25.2	26.3	27.5	29.5	30.5	31.0	30.6	30.9	30.4	31.8	31.8	31.3	31.3	32.9	32.8	31.2
Females	Sample	1	2	3	5	7	11	7	8	11	12	7	4	3	7	5	1	2
	Mean Length (in)	27.6	26.9	26.7	28.2	31.4	31.6	31.2	32.4	32.8	32.6	32.6	34.1	31.6	33.7	33.4	33.9	31.5
	Age	26	27	28	29	30	31	32	34	35	38	40						
Males	Sample	9	4	4	1	2	1	6	1	~	2	~						
	Mean Length (in)	32.4	31.4	32.1	29.1	32.2	35.9	32.4	33.3	~	35.9	~						
Females	Sample	2	3	1	1	~	1	1	~	1	~	1						
	Mean Length (in)	35.4	33.9	36.9	35.8	~	33.6	33.5	~	34.7	~	33.8						

Table 5. Sea lamprey wounds on lake trout captured during spawning assessment, 2004.

Gull Island Shoal Complex

Length	#	A1	A2	A3	A4	A1-A3		B1	B2	B3	B4
						Sum	(wounds/100 fish)				
<17 in (<432 mm)	0										
17-20.9 in (432-532 mm)	0										
21-24.9 in (533-634 mm)	102	0	0	0	1	0	0.00	0	0	1	0
25-28.9 in (635-736 mm)	736	0	4	3	27	7	0.95	0	0	1	1
>28.9 in (>736 mm)	575	0	9	28	106	37	6.43	0	0	3	1
Total	1413	0	13	31	134	44		0	0	5	2

Sand Cut Reef

Length	#	A1	A2	A3	A4	A1-A3		B1	B2	B3	B4
						Sum	(wounds/100 fish)				
<17 in (<432 mm)	0										
17-20.9 in (432-532 mm)	2	0	0	0	0	0	0.00	0	0	0	0
21-24.9 in (533-634 mm)	39	0	0	0	0	0	0.00	0	0	0	0
25-28.9 in (635-736 mm)	87	0	0	1	3	1	1.15	0	0	0	0
>28.9 in (>736 mm)	35	0	2	1	4	3	8.57	0	0	0	0
Total	163	0	2	2	7	4		0	0	0	0

Devils Island Shoal

Length	#	A1	A2	A3	A4	A1-A3		B1	B2	B3	B4
						Sum	(wounds/100 fish)				
<17 in (<432 mm)	0										
17-20.9 in (432-532 mm)	0										
21-24.9 in (533-634 mm)	89	0	0	1	0	1	1.12				
25-28.9 in (635-736 mm)	125	0	0	1	0	1	0.80				
>28.9 in (>736 mm)	51	0	0	2	5	2	3.92				
Total	265	0	0	4	5	4		0	0	0	0

Table 6. Catch per 1,000 feet of net (CPUE; total and for native fish) and catch statistics of spawning lake trout at Sand Cut Reef, 1968-2004.

Year	Total CPUE	% Female	Native CPUE	% Native
1968	17.1	18.3	0.4	2.4
1969	18.7	12.3	1.8	9.6
1970	37.5	17.3	2.5	6.7
1971	23.3	16.3	5.7	24.6
1972	48.0	22.7	12.1	25.2
1973	19.9	26.6	5.7	28.6
1974	19.9	18.1	7.3	36.2
1975	17.5	17.6	8.0	45.7
1976	17.7	28.3	8.4	45.2
1977	26.0	10.8	11.6	44.6
1978	27.0	36.0	17.0	63.9
1979	43.9	25.5	25.2	57.4
1980	28.3	14.7	18.7	66.0
1981	22.8	22.1	12.9	56.6
1982	58.3	23.7	27.6	47.0
1983	12.2	26.7	8.1	66.7
1984	39.5	23.7	26.6	59.7
1985	41.5	25.9	22.6	54.3
1986	32.7	32.2	19.6	60.0
1987	13.8	46.3	10.5	75.9
1988	23.5	20.8	17.3	73.8
1989	46.2	14.2	35.9	77.8
1990	45.0	23.3	37.1	82.3
1991	25.8	30.8	21.9	85.1
1992	40.5	22.5	32.9	81.3
1993	34.1	16.5	25.9	75.9
1994	37.2	30.3	31.0	83.4
1995	38.2	16.5	31.0	81.2
1996	18.7	18.3	17.0	90.8
1997	30.0	19.7	25.0	83.3
1998	33.2	16.2	26.3	79.2
1999	47.1	15.0	42.1	89.4
2000	27.3	23.0	24.1	88.3
2001	52.1	18.2	47.2	90.6
2002	20.9	25.7	19.4	92.7
2003	36.4	26.4	33.8	92.9
2004	41.8	12.3	38.7	92.6

Table 7. Effort (ft) fished, catch per 1,000 feet of net (CPUE), and catch composition of lake trout from spawning assessment at Devils Island Shoal, 1974-2004.

Year	Effort (ft)	CPUE	% Female	% Native
1974	3900	0.5	0.0	0
1975	3900	0.8	0.0	0
1978	7800	0.6	0.4	38
2001	3900	93.3	10.0	97
2004	3900	67.9	1.0	98